

its units are no longer subject to experiment? Most assuredly not."

Our author undertakes the herculean task, we venture to think successfully, of setting the study of phylogeny on a surer foundation. The reason that phylogenetic inquiry has become discredited is that the majority of biologists are neither so stupid that they are content to dabble with phylogeny nor clever enough to make it a great and fruitful sphere of inquiry—a field fit for the exercise of the highest intelligence.

The experimental method has its limitations no less than its fascination. It is not merely a paradox to say that in biology those things with which we can experiment most are those which to the organism matter least. The reason is that we are not the first to start experimenting. Nature has been there before. For example, the range of continuous variation in an organism may either be the direct result of the constitution of the living substance or it may have been determined by the most stringent selection acting since life dawned. If, therefore, we institute experiments on variation—for example, the determination of the effect of heat on the range of variation—we may either be studying one of the simple properties of protoplasm or discovering the limits within which natural selection allows the particular organism dealt with to vary under the conditions of heat, *e.g.*, to which we subject it. The really fundamental processes do not lend themselves to experiment. That is how they have become fundamental. Everyone who wishes to train himself to study them should read Prof. Montgomery's book.

There are a few trifling misprints, *e.g.* "embryoning" in the table of contents; and Mendel worked, not with the sweet, but with the culinary pea.

A. D. D.

ELECTRIC RAILWAYS.

Electric Railway Engineering. By H. F. Parshall and H. M. Hobart. Pp. xxiv+475. (London: Archibald Constable and Co., Ltd., 1907.) Price 42s. net.

THE authors of this work have already introduced a series of technical works upon dynamo design and kindred subjects, and Mr. Hobart is also known as the author of a recent work upon the steam turbine.

In the present volume the authors deal with a wider range of subjects, and, in short, treat of the whole question of heavy "electric traction," that is, traction as applied to railways rather than to street tramways. Such a book was required, and will be welcomed by the growing class of engineers who wish to add to their experience of steam railway work some knowledge of electrical engineering, which is more and more coming to invade the field of traction.

Technical works of this kind may, as a rule, be divided into two classes; on the one hand are the highly technical works which deal with the more scientific aspects of the subject, and of which the

authors' "Dynamo Design" is an example; on the other are the entirely practical works which, at their worst, degenerate into collections of specifications. The present volume endeavours, not unsuccessfully, to combine these two, and to give the reader a clear knowledge of the fundamental principles that underlie the application of electricity to haulage, illustrations of the methods employed in carrying this into effect, and actual examples and details of construction. What it does not fully supply, and what, unfortunately, books of this kind very seldom contain, are the commercial results obtained from the adoption of electric traction. It may be said that this is outside the scope of an engineering treatise; and if the work is to comprise engineering in the sense in which that word was commonly used during the last century the answer is justified, for the engineer of those days was concerned with the question of "will it work?" rather than the question of "will it pay?" But the engineer of the twentieth century has become more and more obliged to look upon the latter as the test of successful engineering, and until a book can be produced dealing with electric traction from the operating point of view such works will not, it is to be feared, have much effect in influencing railway authorities to replace steam haulage by electric traction. Apart from these limitations, however, the present volume is most valuable, for although a considerable portion of the matter has been already published in one form or another, there was a great need for bringing together all that has been done and written.

The choice of the system to be adopted upon any particular part of a railway, although necessarily influenced by first cost, should ultimately be dependent upon its suitability for use upon the railway as a whole, and the results obtained from electrification must be judged in reference to the whole railway undertaking rather than in connection with one section. In connection with the vexed question of the relative advantages of direct current, single phase or three phase, the authors do not undertake to predict the form that the ultimate electric railway installation will assume, contenting themselves with pointing out the merits of each, and emphasising the fact that standardisation has been one of the great elements of success in steam railway working, and that the adoption of electric traction upon railways in the future will be slow until standardisation is adopted.

Coming now to the contents of the book itself, it consists of three parts, dealing respectively with the mechanics of electric traction, the generation and transmission of the electrical energy, and the rolling stock. Chapter i. deals with "tractive resistance at constant speed," and gives the results of applying both theoretical and arbitrary formulæ to the result obtained in actual practice.

Chapter ii. deals in a similar manner with the problem of acceleration. Many useful curves of acceleration, speed-time, and speed-distance are given. Chapter iii. deals with tractive force in relation to acceleration, while chapter iv. deals with the

characteristics of railway motors, upon the design of which Mr. Hobart is an acknowledged authority. Throughout the whole of this section a liberal use is made of graphical methods, and a number of curves referring to the energy consumption under different conditions in actual practice is given.

Chapter v. deals with the generating plant, and is, in our opinion, so far as the practical value of the information contained is concerned, scarcely so useful as the rest of the book; considerable space is devoted to descriptions of tramway generating stations, which, however up to date at the time of construction, are hardly representative of the most modern practice. The question of power-station design is a subject of its own, and is not one upon which the railway engineer, pure and simple, is often called upon to express an opinion. A design is given, however, of a proposed 10,000-kilowatt station, but, so far as can be judged from the drawing, the "complete unit" system by which, for safety reasons, the plant and buildings are entirely subdivided does not appear to be recommended. Interesting tables of the comparative cost and annual over-all efficiencies of various generating stations are given.

A chapter upon the transmission of the electrical energy calls for no particular comment; sections of the cables adopted on various railway systems and the sizes of such cables are given. Particulars are also given of the cost of these cables, but the value of this is, of course, greatly dependent upon the price of copper. Substations are next dealt with, details being given of a very large number of actual substations used in railway work.

Chapter viii., dealing with the distributing system, in other words the third rail, is of more interest, and contains a number of tables dealing with recent practice in this connection; overhead work is also illustrated, though not so fully as could be wished.

Part iii. deals with rolling-stock, and is replete with illustrations and working drawings of locomotives and carriages. This portion of the book, however, shows signs of haste in editing, and in future editions we would suggest that the efficiency curves of motors which it contains, and, in fact, the reference to motors generally, should be gathered together in one section, namely, chapter iv., where most of them are already to be found, instead of being again dealt with under locomotives; certain of the data of rolling-stock given in chapter iv. would, in our opinion, be more easily found in the chapter which is specially devoted to that branch.

These are, however, minor criticisms. The work is one of great practical value to all railway engineers, and will be further enhanced if in future editions more actual illustrations of the total costs of operation of electrified steam railways can be furnished. The North-Eastern Railway, the Lancashire and Yorkshire, and the District Railways have all been in operation long enough to furnish data of the greatest commercial value.

The general "get up" of the work is excellent, as are the reproductions of the various drawings.

OUR BOOK SHELF.

L'Année technique, 1906. By A. Da Cunha. Pp. xii + 237; illustrated. (Paris: Gauthier-Villars, 1906.) Price 3.50 francs.

SINCE 1901 the author has each year prepared in attractive form a concise summary of recent progress in engineering, and his series of volumes cannot fail to prove of inestimable value to the student of French industrial history. His annual summary is not a mere compilation of disconnected notes, but a collection of essays written with originality, technical knowledge, and literary skill.

The subjects dealt with in the record for 1906 comprise accidents in works, the heating and water-supply of houses, public works, and locomotion. A museum illustrating the prevention of accidents in works having recently been inaugurated at the Conservatoire National des Arts et Métiers, Paris, the author has seized the opportunity of dealing at some length with the subject of industrial hygiene, and describes the museums that have been established with the object of bringing to public notice the arrangements that have been found by experience adapted for the protection of workmen in various industries. Museums of this kind exist at Zurich, Amsterdam, Vienna, Munich, Berlin, and Paris. The problem of efficaciously heating dwelling-houses is one that has long been under consideration. The old French fireplace, in which, it has been said, the hottest place is at the roof, has been superseded by modern fireplaces, by fixed or movable stoves, and by heating with steam or hot water.

Many ingenious improvements are described by the author, who also gives some useful advice on this important topic. Other interesting subjects dealt with include the installation of the huge compressed-air caissons for the passage of the Paris Metropolitan Railway under the Seine, the recent developments in automobile transport, and locomotion on ice and snow. The numerous illustrations have been carefully chosen and well executed, and the volume is produced in an attractive style at a modest price. Mr. Alfred Picard contributes a preface, which, like the rest of the volume, may be studied with profit and pleasure, not only by the engineer, but also by the general reader desirous of acquainting himself with the events of the day.

Diseases of Fruit and Fruit-bearing Plants. (Board of Agriculture and Fisheries.) Seven diagrams and text. (London: Printed for H.M. Stationery Office by Darling and Son.)

THE Board of Agriculture and Fisheries has issued a series of seven small coloured diagrams illustrative of a number of common diseases met with in cultivated plants, especially those which are grown for the sake of their fruit. They are adapted for use in schools in the country districts. They illustrate the general appearance of the diseased fruits, without any botanical details. Indications are given as to the best methods of prevention. The use of Bordeaux mixture is frequently and judiciously recommended, but no instructions are given as to the way in which the mixture should be prepared. It is certain that, in spite of the publicity which has been given to this excellent fungicide, many cultivators do not yet know how to prepare it. The use of liver of sulphur is also recommended, but the caution is not added that it should not be allowed to come in contact with the paint on frame or greenhouse so as to prevent the discoloration that would otherwise ensue.

No attempt is made to indicate the degree of injury inflicted by various fungi; thus the first of the series, the "strawberry leaf-spot," is of very little conse-